Final Operations Report

NORTH DAKOTA CLOUD MODIFICATION PROJECT

State of North Dakota | Atmospheric Resource Board | State Water Commission

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Contractor's Summary Submitted By:

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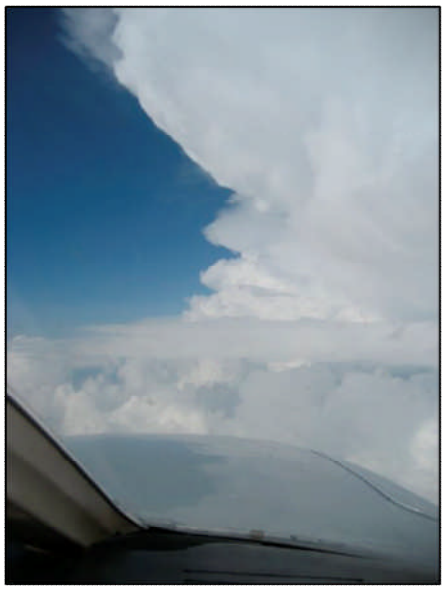
EXECUTIVE SUMMARY

Weather Modification, Inc. (WMI) provided cloud seeding services during the 2009 North Dakota Cloud Modification Project (NDCMP), the third season of the current three-year contract with the North Dakota Atmospheric Resource Board (NDARB). WMI pilots conducted hail suppression and rain increase cloud seeding in western North Dakota under the direction of state-hired radar meteorologists. WMI provided eight specially modified aircraft, seeding equipment, pilots, aircraft maintenance, aircraft data systems, aircraft tracking and telemetry, intern copilot training, and communications equipment in the state radars. This report details WMI activities during the 2009 NDCMP field operations.



View out the windshield of N812V while cloud top seeding near Williston, ND.

The cloud modification services contract for the 2009 season specified two cloud-top seeding aircraft and six cloud-base seeding aircraft, all equipped with aircraft tracking and data acquisition equipment. Operations were conducted on a 24-hour per day, 7-day per week basis. The project period ran from June 1 through August 31 in Williams, Mountrail, and McKenzie counties in District II with an extension to September 8 for Bowman County in District I and Ward County in District II.

District I operated in Bowman County, and, Conner, Hume, Carrol, Cash, Sheets, Mineral Springs, and Cedar Creek Townships of Slope County. Two cloud-base aircraft were based in Bowman. One of the aircraft in Bowman was capable of conducting cloud-top seeding if needed, and was called upon for that purpose a few times. District II operated in Williams, McKenzie, Mountrail, and Ward Counties. One cloud-base aircraft each was based in Stanley and Kenmare, and two cloud-base aircraft were based in Watford City. The cloud-top aircraft were based in Williston and Minot.

Rain enhancement flights were conducted in both districts throughout the season. However, this year rain enhancement suspended for harvest in late August, unlike the 2008 project that saw no rain enhancement suspensions. District I this season experienced a more active wet weather pattern than previous years. A summary of project data shows that the eight project aircraft flew a total of 479.75 hours, dispensing 99.10 kilograms (218.02 lbs) of silver iodide and 2360.37 lbs. of dry ice pellets.

This year marked the 49th season Weather Modification, Inc. has provided cloud seeding services in North Dakota. WMI would like to acknowledge the collaboration and support of all organizations and individuals who made the 2009 project a success! Thank you for your continued support and commitment to cloud seeding in the state of North Dakota.

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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

S6, N121WA on the ramp in Watford City, ND.

North Dakota farmers have historically faced above-average crop losses due to hail and drought; these challenges have contributed to reduced crop yields and farm incomes. This led to the search for ways to manage these conditions, which would consequently improve the average North Dakotan's way of life. One technology that presented hope was the emerging science of weather modification. The first cloud seeding activities of record in North Dakota occurred in 1951, performed by farmers using ground based generators. In 1961, the founders of Weather Modification, Inc. first used aircraft in North Dakota for a program to suppress hail in a target area of 540 square miles, in the central area of what is now District I. This program has been active in some form each year since, with the exception of 1990 when District I did not participate in cloud seeding operations due to budget constraints. The history of District II is very similar, starting one year later and remaining active in various counties every year since. A third district, including Benson, Nelson, and Griggs Counties, started operations in 1974 and was active through the 1981 season. In the mid 1970's, there were 17 counties in North Dakota participating in the cloud seeding program. This number has decreased due to various factors over the years, but currently there are 6 active counties in target areas that cover 10,425 square miles (or, almost 6.7 million acres) – nearly 15% of the state's area. This year marked the 51st consecutive season of some form of seeding in Ward County.

Early funding was accomplished by voluntary contributions through farmer organizations formed for this purpose. In 1965 and 1969 legislation was passed enabling counties and townships to levy two mills for funding of cloud seeding projects. Further legislative action in 1975 established a state Weather Modification Board, now known as the Atmospheric Resource Board, and appropriated money to match county funds and to pay for Board operations. This funding has increased stability at the state and county levels, allowing increased organizational sophistication of the project to a degree unequaled by other current operational programs. The recently concluded 2009 program was the 35th consecutive season under the Board's direction.

The North Dakota Atmospheric Resource Board is comprised of seven members appointed by the Governor of North Dakota. Each member represents a geographic district and serves a four year term. Weather modification authorities within the districts establish possible candidates through nomination. Ex-officio members also serve on the board. 2009 NDARB Members are listed below. 2009 ex-officio members include: Mr. Dale L. Frink (State Engineer, ND State Water Commission), Mr. Larry Taborsky (Director, ND Aeronautics Commission), and Mr. Steven Weber (Environmental Scientist, Environmental Health Section, ND Department of Health).

District	Current Member	Location
District 1	Mr. Ervin Opsal	Williston, ND
District 2	Mr. Hank Bodmer (Chair)	Kenmare, ND
District 3	Mr. John Bollingberg	Bremen, ND
District 4	Mr. David Hagert	Emerado, ND
District 5	(vacant)	
District 6	Mr. Tom Tupa	Bismarck, ND
District 7	Mr. Bobb Brewer (Vice Chair)	Bowman, ND

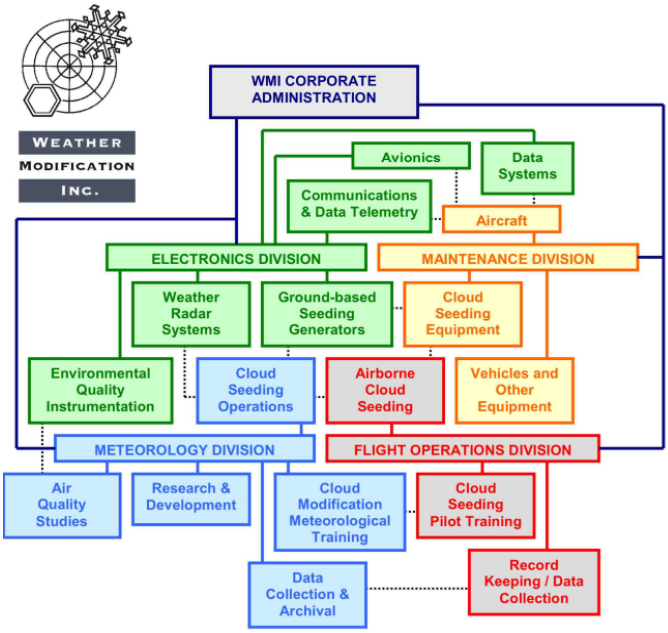
1.2 CONTRACTOR'S BACKGROUND

Weather Modification, Inc. (WMI) was founded in 1961 in Bowman, North Dakota, and has since become a world leader in the areas of hail suppression and precipitation augmentation. WMI has provided aircraft, seeding and research equipment, radars, personnel, and company expertise in the areas of cloud microphysics research and air quality sampling for various governmental agencies and private entities around the globe.

Weather Modification, Inc. and Fargo Jet Center, Inc. company facilities located at the North General Aviation Ramp of the Hector International Airport in Fargo, ND.

Since it's beginning, Company personnel have logged well over 46,000 hours of actual airborne cloud seeding time. During our 49 years of weather modification experience WMI has pioneered safe and effective techniques for airborne cloud seeding, both day and night. These advances in cloud seeding have made it possible to conduct aircraft cloud seeding operations 24 hours per day, seven days a week. These techniques – many formulated in North Dakota operations - have been employed with continued success throughout the world. WMI relocated to Fargo in 1993, and a sibling company, Fargo Jet Center, Inc. (FJC) was incorporated in 1994.

Fargo Jet Center, Inc. provides a range of aviation services including a Federal Aviation Administration approved on-demand charter flight department, aircraft refueling services, FAA approved aircraft maintenance and overhaul facility, aircraft rental and flight instruction. With the acquisition of Waypoint Avionics in 2001, further expertise and capability has been added to the mix. The operating companies frequently share resources, skills, talents, and equipment - each contributes to the success of the other. The synergy realized from several multi-faceted operating companies accents a strong aviation enterprise that continues to grow in size, professionalism and competence.



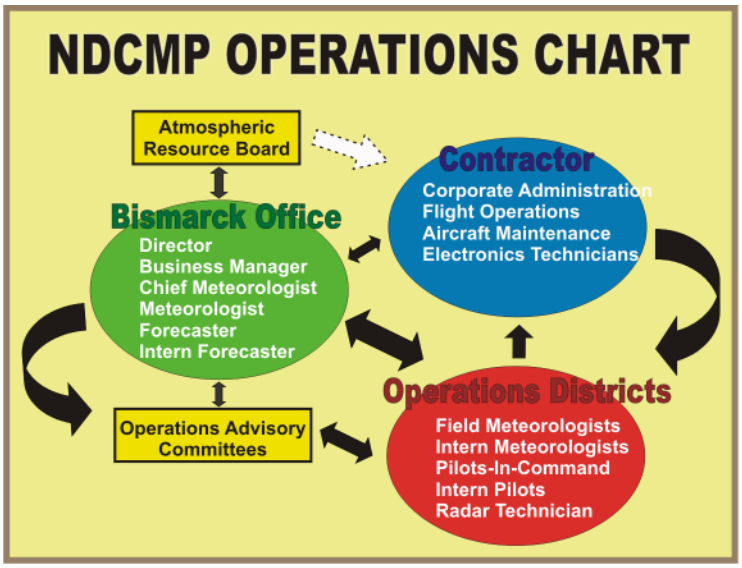
Corporate Structure of Weather Modification, Inc.

WMI is organized into Company Officials, Administration, and four separate divisions. An organizational chart is depicted on the left. Though each of the four divisions has specific responsibilities; frequent interactions (shown by dashed lines) ensure that they function collectively as a cohesive team.

1.3 PROJECT DESIGN

The design of the 2009 North Dakota Cloud Modification Project was based on techniques developed and refined over years of operational programs. These techniques, many developed here in North Dakota, were used in conjunction with seeding criteria evolved by compatible research programs and the comprehensive North Dakota Cloud Modification Project Operations Manual, March 1993, latest revision May 2005.

As set forth by NDARB, the project design is "a non-randomized, development and operational program for the purposes of decreasing hail damage, increasing seasonal rainfall, and achieving certain development objectives for improved operations". In other words, the project design is one in which any cloud that meets the criteria for increasing rainfall or decreasing hail is seeded (within the limits of equipment and personnel) rather than clouds being chosen on a random basis for seeding. In theory any project member can initiate seeding operations, but in practice the ARB radar meteorologists usually direct when and where the WMI pilots operate. The graphic shown is based on a flowchart in the NDCMP Operations Manual. WMI updated the figure by adding Forecaster and Intern Forecaster to the Bismarck Office location.



North Dakota Cloud Modification Project Operations Infrastructure.

2.0 OPERATIONS

2.1 OVERVIEW

The 2009 season of the North Dakota Cloud Modification Project became active for all aircraft at 12 o'clock noon local time on June 1. The project ended for Williams, Mountrail, and McKenzie counties in District II at 11:59 pm local time on August 31. An extension was needed for Bowman County in District I and Ward County in District II which extended their project season to end at 11:59 pm local time on September 8. Bowman County retained Seeds 1 and 2 for their extension and Ward County retained Seeds 4, 8, and 9 for their extension operations. 11.21 hours were flown during the extension, all on hail missions.

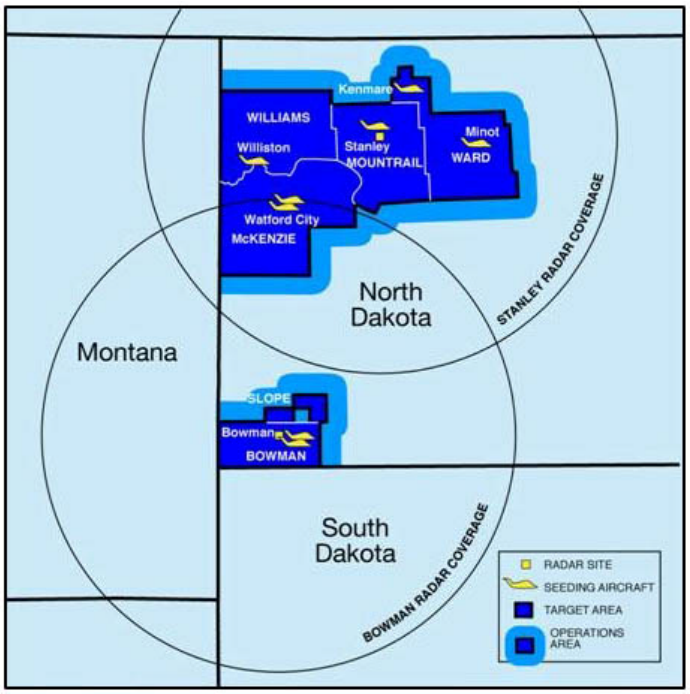
Specialized project forecasts were prepared each morning by ARB staff in Bismarck and were based on National Weather Service data, regional synoptic observations and satellite information. The meteorologists in the field offices received the forecast by approximately 12:00 noon, CDT and then briefed the pilots on expected activities. In the event of significant changes, updates were furnished to the radar meteorologists by phone and/or email.

Radar meteorologists and pilots all kept an eye out for significant weather activity. Sometimes with input from the aircraft crews, the ARB meteorologists launched aircraft for seeding missions. Cloud candidates for seeding were usually chosen by the radar meteorologists, with the pilots making the final determinations based upon storm inflow, cloud structures, flight safety, and other factors.

Counting ARB staff, ARB Board of Directors, the five participating County Weather Modification Boards, Slope County Severe Weather Management Association members, and applicable WMI and FJC staff, there were over 100 people directly associated with some facet of the 2009 NDCMP. This does not include the local vendors and technicians employed by the ARB and WMI during the season.

2.2 OPERATIONAL AREAS

North Dakota weather modification activities were conducted in two operational target areas, or Districts. District I included Bowman County, as well as Conner, Hume, Carrol, Cash, Sheets, Mineral Springs, and Cedar Creek Townships in Slope County this year. District II encompassed Williams, McKenzie, Mountrail, and Ward Counties.



NDCMP 2009 Operational Areas. District I is located in the SW corner of the state while District II is located in the NW. (NDARB graphic)

2.3 AIRCRAFT LOCATIONS

Aircraft bases are determined by the ARB in cooperation with the county weather modification authorities. Airports are chosen using location, runway length, fuel availability, and facilities as factors. The top-seeding aircraft need to have access to instrument approaches to fully utilize their capabilities. Housing availability for the crews is also important.

A Cessna 340A (US FAA registration number N340FR) and a Seneca II (N33144) were based in Bowman, ND for District I operations. District II aircraft were based at Kenmare (Seneca II, N13AG), Stanley (Seneca II, 39655), Watford City (Seneca II's N121WA and N9798C), Williston (C340, N812V), and Minot (C340A, N37356).

WMI also had spare aircraft available in Fargo if needed. This year a spare aircraft was needed to replace Seed 2, located in Bowman. The Piper Seneca had mechanical problems with its landing gear on august 9 and had to return to Fargo to undergo extensive maintenance. A Cessna 340, FAA registration N37360, was sent out as a replacement aircraft on August 10. Seven flights were conducted after this switch for a total of 7.66 hours of operational seeding flights.

2.4 RADAR LOCATIONS

Two Enterprise Electronics Corporation WSR-74C 5-cm weather radars, both owned by the ARB, were employed on the project. These radars are surplus National Weather Service units, purchased and moved to the project sites. One unit each is located at the Bowman and Stanley airports.

NDARB Stanley Radar site, located at the Stanley, ND airports. This facility also provides office space for the radar meteorologists.

A vendor through a separate ARB contract maintained and calibrated the radars. The ARB owns the structure that houses the radar at Stanley, and is donated use of the structure that houses the radar in Bowman from Bowman County. The structure at Stanley was constructed prior to the 1998 field season. This season the chemical shed was relocated closer to the radar building for increased aircraft operation security. Upon its relocation it received a fresh coat of paint from volunteer intern Jeremy Duke.

New for this season, although not done by WMI, each radar site underwent an upgrade to Doppler technology along with other significant improvements. Until this year, except for the displays the radar systems located in Bowman and Stanley went relatively unchanged since they were built in the 1970s. The Doppler technology allows radar meteorologists to see wind motions in the atmosphere which helps them to detect severe storms and those likely to spawn a tornado. One of the biggest improvements, however, is the ability to monitor the radars remotely. This allows the radars to be controlled from a central location rather than requiring dedicated meteorologists on-site. This new upgrade allows the flexibility to operate the radars beyond the summer months, perhaps even year round.

3.0 EQUIPMENT

3.1 AIRCRAFT

For cloud-seeding flight operations WMI uses only well-equipped, twin-engine aircraft. In addition to their high performance characteristics (compared to lower-powered, single-engine aircraft), the twin-engine aircraft provide an extra measure of safety in bad weather, in-cloud, and nighttime operations. All of the seeding aircraft are owned and were modified by WMI.

Aircraft must be flown and maintained in accordance with Federal Aviation Administration rules and regulations. WMI's specially modified cloud seeding aircraft, when fitted with seeding equipment, must be operated in RESTRICTED category – meaning that their operations are limited to the special purpose operations for which the equipment installations are certified by the FAA, and are bound by extra rules which prohibit these aircraft from carrying passengers who are not part of the project, among other things. All aircraft must also be inspected and maintained according to approved schedules; the Seneca's and C340's used on this project must all have a yearly inspection ("annual inspection") and certain required maintenance checks at each 50 and 100 hours of operation.

As in recent seasons, eight seeding aircraft were specified by the 2009 contract. WMI operated five Piper Seneca II (PA34-200T) aircraft and one Cessna 340 aircraft for cloud-base seeding. Two more Cessna 340 aircraft were primarily used for cloud-top seeding, though they also were equipped with generators for cloud-base work. WMI's Piper PA34-200T Seneca II aircraft are turbocharged, twin 200-horsepower engine light aircraft. WMI's Cessna 340's are turbocharged, twin 310-horsepower engine aircraft with pressurized cabins. Besides North Dakota, WMI has operated these types of aircraft on projects in Canada, Mexico, UAE, Greece, Turkey, India, and multiple US states. They have proven well capable of absorbing the stresses ordinarily encountered while seeding clouds.

Seneca II - N33144 and Cessna 340 - N340FR on location in Bowman, ND.

Unmodified Seneca II's attain maximum normal cruise speeds of 203 mph (177 kts) and a climb rate of 1340 feet per minute, a single engine ceiling of 13,400 ft and an all engine service ceiling of 25,000 ft. C340's can cruise at speeds of 263 mph (230 kts) with a rate of climb of 1650 fpm, a single engine service ceiling of 15,800 and an all engine service ceiling of 29,800 feet. It must be understood that with the external seeding equipment installed, seeding aircraft performance figures are reduced. All of WMI's seeding aircraft are equipped for flight in icing conditions should the need arise. In addition to normal aircraft and seeding systems, all aircraft furnished for the project were equipped and certified for instrument flight rules (IFR) and had GPS navigation equipment.

Prior to the 2009 season all WMI project aircraft underwent renewed annual inspections (as required by the FAA) and had the appropriate WMI seeding equipment mounted to conform to the project contract requirements. Project pilots assisted WMI and FJC mechanics in Fargo to prepare the aircraft. This provided the pilots with valuable training and hands-on experience with seeding equipment and their aircraft. All seeding generators were flight tested with acetone before delivery to ensure proper operation.

All eight project aircraft were delivered to their sites on May 26-29, after the conclusion of the ground school in Bismarck. VHF and data radios for the Bowman and Stanley radars were delivered with the aircraft. All of the WMI pilots mixed solution, filled their burners and flare racks, and conducted test flights by sometime on June 1, and were thereafter ready for missions.

WMI has the ability to quickly dispatch mechanics to a project site when maintenance concerns arise if a local shop could not get to the work quickly. WMI Project Manager Hans Ahlness made a number of aircraft repairs during the project and while filling in for other pilots. Local mechanics and shops in Minot, Bowman, and Williston performed some scheduled and unscheduled maintenance. All pilots assisted in troubleshooting efforts in the field. Most aircraft maintenance, 50- and 100-hour inspections were done in Bowman, Williston, Watford City, Minot, and Fargo. Major problems and inspections were brought to Fargo as weather permitted, where more mechanics, facilities, and parts could quickly be brought to bear.

The Pilot-In-Command (PIC) of each aircraft was instructed to call immediately when unscheduled maintenance was required. Each PIC also called WMI Project Field Representative Nick Peacock (Williston Seed 7 PIC) on Monday of each week to provide the status of their airplane and to provide the airplane's total flight time for maintenance tracking. Mr. Peacock used e-mail and telephone to keep WMI's Project Manager apprised of any problems with aircraft, seeding equipment, or personnel.

The NDCMP is a very aircraft-intensive program, and with eight twin-engine aircraft flying in turbulent thunderstorm conditions it is a given that maintenance problems will occur. WMI's goal is to anticipate problems as much as possible, and manage them so that no seeding missions are missed.

With 8 aircraft operating exclusively around bad weather, there are always some maintenance events during the summer that delay or limit some operations. On Wednesday June 17, the Williston top seeding aircraft (Seed 7, N812V) had to go to Fargo to replace the LH engine due to a cracked crankcase; the airplane returned to Williston on Friday June 19. On Monday June 29, Seed 5 (N9798C) made the trek to Fargo for turbo maintenance on the RH engine, returning to Watford City that evening. Seed 2 (N33144) in Bowman had a partial collapse of the RH landing gear after a mission on the afternoon of Sunday, August 9. Hans Ahlness and Jody Fischer outfitted a spare WMI 340A, N37360 and brought it out to Bowman the next day to replace the stricken Seneca, and once parts were obtained and installed Ahlness ferried the former Seed 2 back to Fargo on August 31. The WMI pilots did a good job again of handling various other mechanical maladies and helping WMI maintain the aircraft to continue safe operations.

3.2 SEEDING EQUIPMENT

WMI designs, manufactures, and operates a wide variety of seeding equipment. Each PIC received operation and maintenance training on the seeding equipment. WMI maintains an extensive inventory of seeding equipment spares that was restocked as needed during the project. WMI also maintains an inventory of spare parts for the airplanes used on the project to avoid downtime waiting for parts.

Seneca II – N121WA base seeding near Watford City, ND. Visible is a lit Lohse Generator.

Each **cloud base aircraft** was outfitted with the following equipment:

- Two WMI-Lohse ram-air pressurized liquid-fueled AgI generators, with a 7-gallon usable capacity, calibrated to a flow rate of 3.0 gallons per hour at 120 mph airspeed.
- Two wing mounted flare racks, each capable of carrying 12-16 "burn-in-place" flares.
- (C340 only) Two belly-mounted ejectable flare racks, 204 flare capacity total.

The Cessna 340 **cloud top aircraft** stationed at Minot and Williston were equipped with:

- Two flare racks capable of firing 204 total (20 gram AgI) ejectable flares for cloud top seeding.
- A 150 lb. capacity dry ice dispenser for cloud top seeding.
- Two WMI-Lohse ram-air pressurized liquid-fueled AgI generators for base seeding.

The Cessna 340 based in Bowman was also capable of top seeding with an ejectable flare rack, but was not equipped with a dry ice dispenser.

(Above) WMI 102-count Ejectable Flare Racks mounted to the belly of a top seeding aircraft. The 20-gram flares are housed within the removable baskets on the bottom of each rack.

(Left) WMI Burn-In-Place flare rack with 75 gram Silver Iodide flares. These racks mount on top of the aircraft wings.

All of the seeding materials used during the project were supplied by the ARB. These included dry ice pellets, silver iodide flares (both ejectable and burn-in-place), and a silver iodide solution. This solution's mixture contains silver iodide, ammonium iodide, paradichloro-benzene, and sodium perchlorate, all dissolved in acetone. Chemical formulations have evolved with research and experience, and now incorporate ingredients that make the formulas faster acting - better for hail suppression. The seeding solution was mixed at the field sites by the WMI pilots. The ARB provided secure storage for the seeding materials at each site.

WMI Lohse Silver Iodide Generator mounted on a Seneca II. The chemical tank is the center section, and the flame is contained within the tailcone. The generator features all stainless-steel construction.

3.3 RADAR DATA SYSTEMS

Each District had a dedicated weather radar system, as in previous years' projects. The NDARB operated two (2) five-centimeter EEC WSR-74C radars located at the Bowman and Stanley airports. In 2009, each radar site underwent an upgrade to Doppler technology along with other significant improvements. Doppler technology allows the radar meteorologists to detect wind motions in the atmosphere which helps them to detect severe storms and those likely to spawn a tornado. One of the biggest improvements is the ability to monitor the radars remotely. This allows the radars to be controlled from a central location rather than requiring dedicated meteorologists on-site. This new upgrade allows the flexibility to operate the radars beyond the summer months, perhaps even year round.

The NDARB provided "Thunderstorm Identification, Tracking, Analysis, and Nowcasting" (TITAN) systems for each radar, software originally developed by scientists from the National Center for Atmospheric Research (NCAR). A third TITAN system was set up in the ARB offices in Bismarck for use in data analysis.

The antenna pedestal is the elevation-over-azimuth type. The dish is parabolic, 8 ft (2.4 m) in diameter, constructed of aluminum and installed within a 12 ft (3.7 m) diameter fiberglass radome, which allows continuous operation even in strong, sustained winds. The antenna assembly is positioned on a steel tower at the Bowman Airport, and atop the radar building at Stanley, at an adequate height to provide the best possible radar coverage for the target areas.

TITAN is an acronym that stands for Thunderstorm Identification, Tracking, Analysis and Nowcasting. While the software was developed with thunderstorms in mind, it turns out that it is flexible enough to handle any meteorological situation. The TITAN system provides 16 levels of contoured color radar reflectivity data, zoom, custom target overlays, instant playback and real-time aircraft flight track/seeding event superimposition. The software runs on a Linux operating system. The TITAN radar display above shows constant altitude PPI (CAPPI), vertical storm cross section, storm history, storm time-height profile and reflectivity distribution. The history of storm motions (yellow circles) and forecast storm motions (red circles) are also shown.

A CAPPI display can be selected for various altitudes starting at 2 kilometer above the surface and stepping up in 1-kilometer increments. It is also possible to create a composite PPI display, which plots the strongest radar reflectivity at any altitude in a PPI format. A zoom function allows the radar operator to zoom-in on interesting features on the CAPPI.

The vertical cross section capability enables a radar operator to produce a two dimensional slice through a thunderstorm. Unlike conventional radar Range Height Indicators (RHI), the vertical cross section option permits cross sections to be made along any two points on a CAPPI and not just along the azimuth from the radar.

Aircraft flight tracks can be superimposed upon the TITAN display, and the field offices and project aircraft have the equipment to do so. Superimposed flight tracks aid the radar meteorologist in directing the cloud seeding aircraft to the most suitable seeding candidates. An electronic overlay generated by a computer file displays the project target area as well as county boundaries and prominent cities and geographical features.

Radar maps and flight track data are saves automatically in approximately 6-minute increments. The time period required to complete a volume scan varies dependent upon the RPM setting of the radar. The large volume of graphical data being recorded and stored is the reason for the necessity of upgrading to a specialized computer. The weather radar data is recorded on to CD-ROM discs for storage and playback at a later time, and the storms can be replayed for future analysis.

The radar maps are automatically sent to the ARB Internet web site every 6 minutes to provide access to recently recorded data. The links (accessible from the ND State Water Commission website, *www.swc.nd.gov/arb*) can be viewed using any PC with an Internet server, and show current radar maps displaying reflectivity data and aircraft flight tracks.

WMI also uses TITAN on its projects throughout the world, and originally supplied the ARB with the software and necessary hardware. Continuing upgrades have expanded the software's capabilities to meet specific individual project requirements.

3.4 AIRLINK GPS-BASED DATA TELEMETRY SYSTEM

The aircraft flight tracking computer program *AirLink*, an exclusive product of WMI, was used in the radars during the 2009 season. The *AirLink* program runs on any Windows computer. *AirLink* has been used for tracking on the NDCMP since 2000.

AirLink is able to provide, in real-time, a display of the seeding aircraft flight paths generated from aircraft GPS data. *AirLink* displays position information, seeding status, and atmospheric microphysical information (if the aircraft is equipped with probes), all transmitted via radio modem from each seeding aircraft to a receiver in the radar. If chosen by the radar operator, files can also be created on the ground computers in the radars to enable playback of flight tracks for later analysis.

AirLink is normally overlaid on the TITAN display, but can use World Aeronautical Charts or other maps as a display background. The map backgrounds enable the radar meteorologists to pinpoint the aircraft's position with respect to radio navigational aids, target area boundaries, and storms. The *AirLink* display can be printed on any PC compatible printer.

AirLink has the ability to display the location and time of the end burning flares ignited or seeding signature from the liquid generators. The event tracking capability allows the radar meteorologists to determine which thunderstorm complexes were seeded and the number of end-burning flares used. The event tracking can also show the location, time and number of ejectable flares or dry ice runs used for the C340 top seeding aircraft.

An improvement to *Airlink* in 2004-2005 allowed for playback of multiple aircraft tracks to be done simultaneously. Prior to this software update, each aircraft file would have to be played separately and manually placed on top of each other to create the composite. This tool allows for entire seeding days/months/seasons to be displayed on one screen. *AirLink* Version 2.5 was provided to the NDARB in 2004.

3.5 AIRCRAFT DATA SYSTEMS

The NDARB contracted with WMI to provide the project radars with the ability to track each seeding aircraft's position, altitude and seeding events. Each aircraft was equipped with a WMI "datalogger" system that is composed of a computer, wireless keyboard, 7" color flat screen monitor and WMI's ADAS (Aircraft Data Acquisition System) software. The computer receives inputs from the aircraft's GPS receiver, silver iodide generators, and the firing systems from the BIP and belly mounted ejectable flare racks. All project aircraft were equipped with a datalogger as part of the telemetry systems that provided position and altitude information as well as seeding events. The datalogger systems were designed and are specially built by WMI in Fargo.

The WMI ADAS system logs the GPS position of the aircraft during the entire flight at a data rate of once per second. The computer also notes the time and location of seeding events. A telemetry radio in each aircraft transmits the ADAS information to the *AirLink* computer in the radar. This information is then sent to the TITAN computer to generate the aircraft tracks on the TITAN display. Files are created on the aircraft computer's hard drive that can then be transferred to a USB drive for later analysis.

The NDARB was provided with the *AirLink* computer software to replay the flight track data for post-flight analysis. The data was downloaded from each aircraft on a regular basis, checked by WMI, and sent to the ARB at the end of the season.

3.6 AIRCRAFT RECORD KEEPING

The NDCMP implemented a new record keeping system starting in 2004. Traditionally, paper flight forms and maps were used in the seeding aircraft to record flight data and flight tracks. When later analysis of the data was needed, it was a time-consuming process to read and enter by hand into a database. Initially tested in 2003, the Personal Digital Assistant (PDA) based system is called the "Palm Aircraft Recordkeeping System", or PARS. The programs for this system were written specifically for use in the NDCMP.

PARS uses a Palm Pilot PDA which is wirelessly interfaced with a portable GPS. Each seeding aircraft was issued a complete system, made up of off-the-shelf equipment, for use during the project. Three separate programs were developed for the system – *BaseFlight*, for cloud base seeding, *TopFlight*, for cloud-top seeding, and *AfterFlight*, for review and editing of flight data. *BaseFlight* and *TopFlight* provide NDCMP pilots with a method to collect the same information as the previously used paper forms while also providing enhancements such as information standardization, programmable position report intervals, and removing the need for hand-drawn flight maps.

The PDA receives position and altitude data from the GPS, which is placed near the aircraft's windshield. The pilots enter appropriate data regarding seeding events and remarks during the flight. The GPS data in the PARS files can be used to create the regular flight forms as well as accurate maps, with seeding areas depicted as entered by the flight crews (shown below). Two additional programs, *ARBSync* and *ChemInv*, are included on the Palm to execute data uploads to the ARB database, and to monitor seeding chemicals and flares at NDCMP field sites.

Once the flight data from the PDA is sent to the ARB through a special modem line, all the data is immediately entered into ARB databases for easy retrieval and analysis. Storage requirements are lessened since paper copies need not be preserved, although copies can be printed out at any time. Flight crews and ARB staff are able to better track chemical inventories at the various aircraft sites as well, leading to increased efficiencies.

3.7 RADIO COMMUNICATIONS

WMI supplied multi-channel VHF (Very High Frequency) aviation-band communications base station radios to be used at each radar field office for communications with the seeding aircraft. WMI also supplied antennae and low-loss cabling at each site for good reception, and power supplies for the radios that ensured adequate transmitting power. With the advent of better radios in both the aircraft and ground stations, VHF communications have become far more reliable than in years past. During operations, aircraft working far from the radar at low altitudes will normally relay through a nearer, or higher, seeding aircraft to communicate with the radar meteorologists. NDARB obtains the appropriate FCC radio station licenses for the radar sites.

4.0 PERSONNEL

4.1 PROJECT ADMINISTRATION

North Dakota Atmospheric Resource Board - Bismarck, ND

Mr. Darin Langerud oversees the NDCMP operations for the ARB. Mr. Mark Schneider manages the radar meteorologists, project forecaster, and intern forecaster. Ms. Kelli Schroeder handles the program funding, contracts, and the pilot intern program. Mr. Daniel Brothers, Meteorologist, handles forecasting as well as office duties including record keeping, PARS, the ARB rain gauge network, and record quality control. Mr. Schneider is a Weather Modification Association (WMA) Certified Weather Modification Operator, and Mr. Langerud is a WMA Certified Manager.

Paul Moen (not pictured), NDSWC IT staff member, helped out with computer and TITAN software issues and wrote and maintained the PDA-based recordkeeping system.

Weather Modification, Inc. – Fargo, ND

Project Managers

Hans Ahlness, Vice President – Operations of WMI was the Primary Project Manager for the 2009 NDCMP. Patrick Sweeney, President of WMI and Bruce Boe, WMI Director of Meteorology served as Co-Project Managers in case Mr. Ahlness needed to travel outside the state. Both Mr. Ahlness and Mr. Sweeney are Weather Modification Association Certified Weather Modification Operators, and Mr. Boe is a WMA Certified Manager. Mr. Sweeney has handled radar technician, pilot, and management duties at WMI since 1975, and has been a shareholder since 1979. Mr. Boe assumed his present position at WMI in 2001. Prior to coming to WMI he served as Director of the ARB for 12 years.

James Sweeney, Vice President of WMI was Assistant Project Manager to aid in the fulfillment of contract obligations. James Sweeney began working at WMI in 1992.

Other Personnel

Hans Ahlness of WMI was also responsible for hiring and training the project pilots, overseeing aircraft operations and aircraft and equipment maintenance, and providing relief pilot and mechanic duties. Mr. Ahlness has worked in the weather modification field since 1977, with duties including radar operator, mechanic, operational and research pilot, and manager. He has worked at WMI full time since 1985.

Nicholas Peacock, District II Project Pilot, served as the Field Representative for WMI during the season. All North Dakota WMI field personnel reported problems and equipment status to him, and he then provided summaries to Mr. Ahlness. He also assisted with pre-season seeding equipment maintenance and project pilot flight training. Mr. Peacock has worked as a project pilot on several WMI programs since 2006. This was his fifth season on the North Dakota Cloud Modification Program.

Ed Fandrich, Fargo Jet Center mechanic, serves as the main WMI liaison in the Fargo Jet Center shop. Mr. Fandrich started working at FJC in 2004.

Dennis Afseth, WMI Chief of Electronics, oversaw computer, datalogger, and software support during the project. Mr. Afseth has been employed at WMI since 1993. WMI technicians Kelly Bosch, Ryan Richter, and Derek Anderson provided computer support and assisted Mr. Afseth.

Cindy Dobbs, WMI Office Manager, coordinated administrative activities during the project period. Ms. Dobbs began working at WMI in 1993.

4.2 METEOROLOGISTS

All meteorologists and their assistants were employed by the NDARB. The internship program continued. Two meteorology interns were chosen to spend the season as assistant meteorologists in both Districts I and II as in previous seasons, and two other interns were selected to assist with forecasting from the Bismarck office for the first time. ARB field personnel working on the 2009 Project were:

	Name	Title	Location	Experience
NDARB Office	Mark Schneider	Chief Meteorologist	Bismarck	7 Years
	Daniel Brothers	Meteorologist	Bismarck	7 Years
	Sean Rocheford	Intern Forecaster	Bismarck	1st Year
	Chris Hammer	Intern Forecaster	Bismarck	1st Year
District 1	Daniel Gilbert	Meteorologist	Bowman	7 Years
	Joe Pehoski	Intern Meteorologist	Bowman	1st Year
District 2	Phillip Genskow	Meteorologist	Stanley	2nd Year
	Matt Ham	Meteorologist	Stanley	1st Year
	Erik Janzon	Intern Meteorologist	Stanley	1st Year

DISTRICT I - METEOROLOGIST

INTERN METEOROLOGIST

DISTRICT II - METEOROLOGIST

INTERN METEOROLOGIST

DISTRICT II - METEOROLOGIST

4.3 ELECTRONICS AND COMPUTER MAINTENANCE

ND State Water Commission IT technician Paul Moen handled issues with the TITAN software and hardware systems in both radars. WMI installed and maintained the datalogger computers and electronics in the aircraft, including *AirLink*.

4.4 AIRCRAFT MAINTENANCE

All pre-season and major aircraft and seeding equipment maintenance was performed at Fargo Jet Center, Fargo, ND. Smaller items were taken care of by local maintenance shops in the project areas. Hans Ahlness, WMI Vice President - Operations (FAA Airframe & Powerplant mechanic, Inspection Authorization) tracked and supervised the required maintenance and support for the aircraft in the field. Mr. Ahlness also performed required maintenance on aircraft while in the field.

Other WMI technicians and pilots who assisted in the preseason work were Jody Fischer, Dennis Afseth, Kelly Bosch, and Ryan Richter. Mickie Bosch (FJC parts manager) supplied parts for the aircraft in the field.

FJC mechanics who worked on ND project aircraft prior to or during the season were Brent Allen, Chris Eggl, Darcy Charles, Edward Fandrich, Keith Murray, Mike Koenig, Mike Clancy, Norris Williams, Pat DeWitt, Rafe Zerbe, Scott Mathews, and Troy Herberholz. Avionics technicians contributing were Kris Hexom, Randy Jasken, Chris Kimpel, Dave Mohn, and John Utpadel.

4.5 PILOTS & INTERN CO-PILOTS

	PIC Name	Aircraft	Location	Experience
District 1	Eric Miller	N340FR	Bowman	4 Years
	Jesse Bader	N33144/N37360	Bowman	1st Year
District 2	Ryan Perrin	N39655	Stanley	2 Years
	Eric Strohacker	N9798C	Watford City	2 Years
	Ryan Guthridge	N121WA	Watford City	2 Years
	Nick Peacock	N812V	Williston	5 Years
	Ben Burgeson	N13AG	Kenmare	4 Years
	Brook Herridge	N37356	Minot	4 Years
Relief Pilots	Hans Ahlness	-	Fargo	33 Years
	Jody Fischer	-	Fargo	10 Years

	Name	Location
District 1	Tony Tollefson	Bowman
	Mitchell Drozdowicz	Bowman
District 2	Octavian Ciobanu	Watford City
	John Myers	Watford City
	Tanner Overland	Williston
	Jeremy Duke	Stanley
	Drew Sinkey	Kenmare
	Sean Liebers	Minot
	Peter Van Duzer	Rover

The flight crew was led by veteran Nick Peacock, in his fifth season on the North Dakota Project. Hans Ahlness flew the Williston airplane for the first 3 weeks of June while Peacock was off to get married. Seven of the PIC's had previous experience on the NDCMP. The ND experience levels for the pilots are shown at the end of the 2009 season. Some of the pilots have also worked on other WMI projects during the winter seasons. Eric Miller has worked 2 winters flying in Boise, ID and 1 winter in CA, Nick Peacock has flown the last 3 winters in CA, Brook Herridge and Ben Burgeson spent the last 2 winters in CA, Jesse Bader flew last winter in CA, and Eric Strohacker flew last winter in Boise, ID.

DISTRICT I - S2 PILOT

DISTRICT I - S2 INTERN PILOT

DISTRICT I - S1 PILOT

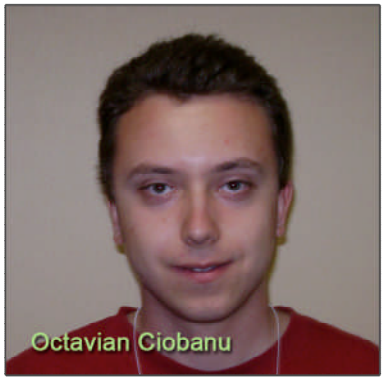
DISTRICT I - S1 INTERN PILOT

DISTRICT II - S4 PILOT

DISTRICT II - S4 INTERN PILOT

DISTRICT II - S5 PILOT

DISTRICT II - S5 INTERN PILOT



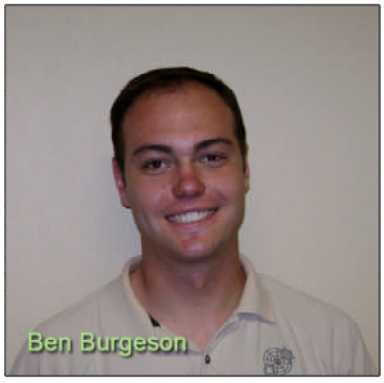
DISTRICT II - S6 PILOT

DISTRICT II - S6 INTERN PILOT

DISTRICT II - S7 PILOT

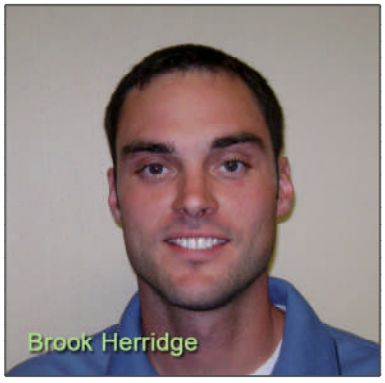
DISTRICT II - S7 INTERN PILOT

DISTRICT II - S8 PILOT



DISTRICT II - S8 INTERN PILOT

DISTRICT II - S9 PILOT



DISTRICT II - S9 INTERN PILOT

ROVER INTERN PILOT

The co-pilots completed the Advanced Weather Modification course at the University of North Dakota, and were selected from the class for their internships through a ranking process. Mike Poellot, Chair of Atmospheric Sciences at UND, directs the internships. Kelli Schroeder oversaw the intern program for the ARB. The interns all rotated through Minot and Williston to gain additional experience in the top seeding aircraft. Most of the interns returned to school before the end of August.

The pilot internship program is funded by the ARB. The intern pilots are paid an hourly wage and are required to maintain a timesheet of their project activities. The Pilot Internship Program was initially begun in 1974 by the Bureau of Reclamation. A memorandum of Understanding (MOU) between the ARB and the University of North Dakota has been in place since 1975. At the completion of the 2009 program, the program has provided training and experience for 300 pilots.

The NDCMP Meteorology Internship Program began in 1996 and to date has provided hands-on radar, operations and forecasting experience for 32 meteorology undergraduates.

4.6 GROUND SCHOOL 2009

Ground School 2009. Left – Flight crews practice using their PDA. Right – WMI Pilot Nick Peacock explains how the Lohse generator works during ground school in Bismarck.

The 2009 North Dakota Cloud Modification Project Ground School was conducted in Bismarck, ND on May 20-22. Atmospheric Resource Board and WMI personnel conducted the ground school, which was held at the ND State Water Commission building. Various aspects of the program were discussed such as responsibilities of all personnel, cloud physics, opportunity recognition, use of chemicals, project documentation, safety procedures and certain lessons from previous projects that might help to improve efficiency of the 2009 program.

The pilots and co-pilots received extensive training on the design, maintenance and operation of seeding equipment before the project and during ground school. The training included classroom lectures and hands-on experience with TITAN computers, seeding aircraft and associated seeding equipment.

Prior to ground school the intern copilots received flight training from WMI pilot Jody Fischer, to give them the proper FAA certifications to act as pilots in the WMI high-performance aircraft used on the NDCMP. These certifications are not normally earned during flight training at UND. WMI charges the intern copilots a nominal fee which does not cover the actual costs of the aircraft and instructor.

Seven of the eight PIC's and both relief pilots had previous experience cloud seeding as either PIC or SIC on the NDCMP or another weather modification project. Training and re-familiarization flights were conducted during periods of thunderstorms in May. WMI training pilots were Hans Ahlness and Jody Fischer.

Each pilot was checked out in his or her designated aircraft before the beginning of the project. Either Ahlness, Fischer, or Peacock flew with each pilot to ensure that they were familiar with the airplane systems and the operation of the seeding equipment. The pilots were also instructed on the airspeeds and power settings used during a seeding mission. The flights also provided quality assurance to verify the flying abilities of each pilot. All of the pilots were involved in the preseason maintenance and flight testing of airplanes and seeding equipment.

WMI Pilots, Eric Strohacker and Ryan Gutheridge perform field maintenance on N9798C's burner.

Numerous questions and problems typically surface during the project as problems arise and remedies are explored. It is invaluable to have experienced personnel in the field during the season to resolve these problems. ARB Chief Meteorologist Mark Schneider and ARB Director Darin Langerud were always available for advice and answers whenever their radar meteorologists needed guidance and all project personnel were given copies of the NDCMP Operations Manual and Radar Applications Manual as appropriate prior to the season start. Hans Ahlness provided support for WMI field personnel during the season. Mr. Ahlness worked with pilots and meteorologists alike and provided insights into seeding systems and seeding strategy. The WMI Pilot Information Manual, written by Mr. Ahlness with contributions from other WMI project pilots, is used by WMI project pilots as a training and reference aid, supplementing the NDCMP Operations Manual. Mr. Ahlness handled weather and aircraft questions, helped write the equipment manuals, and provided additional training for field personnel during the project.

5.0 CONTRACTOR'S REMARKS

FLIGHT TIME AND SILVER IODIDE CONSUMED BY DI ANDDII AIRCRAFT 5–YEAR SUMMARY										
	Flight Time (Hours)					Silver Iodide (kg)				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
District I Cloud Base	130.66	95.78	83.55	95.11	112.15	39.30	28.65	22.95	33.63	35.69
District I Cloud Top	NA	NA	NA	11.23	21.88	NA	NA	NA	3.01	5.40
District II Cloud Base	284.88	307.59	315.78	303.77	231.18	76.96	62.99	66.66	81.70	46.39
District II Cloud Top	177.48	192.7	170.26	153.85	114.54	47.12	13.70	11.54	16.66	11.61
TOTALS	593.02	596.07	569.59	563.96	479.75	163.37	105.34	101.15	135.00	99.10

DRY ICE CONSUMED BY TOP SEED AIRCRAFT - 2004-2009 SEASONS					
2004	2005	2006	2007	2008	2009
5568.5 lbs	4917.9 lbs	5149.5 lbs	2856.7 lbs	2319.19 lbs	2360.37 lbs

WMI's contract with the ARB states: "*Generator performance shall be calculated by dividing the total time the generators were inoperative by the total aircraft seeding time. The resulting figure will represent the percentage of time Project aircraft were operating at less than desired capability."* The "generator failure rate" for the 2009 season was 3.78%. This amounted to less than six hours of flight time that one of the seeding generators was inoperative on one of the eight seeding aircraft during the summer. A quick look at the generator times shows that the average base seeding flight (rain or hail) has one or both seeding generators ON for about 46% of the duration of the flight. The rest of the time is transport to, from, and between storms, or searching for inflow areas.

6.0 PUBLIC RELATIONS

Since 1951, cloud seeding in the state of North Dakota has been a grassroots effort. Public participation has always been a local decision, and the base of support for the program. Over the years several North Dakota cities have welcomed the NDCMP crews. Community involvement by project personnel during their summer stays is always encouraged. This season Bowman project personnel manned the ND Weather Modification Association information booth showing the project's techniques and operations on display July 10-12th at the Bowman County Fair. Project personnel in Watford City presented a brief explanation of the project for the Watford City Rotary Club, and participated in the Watford City High School Athletic Boosters Golf Tournament. During these events, pilots and/or meteorologists field questions about the program and its operations.

Each season ARB staff members decide whether to give out a couple of project awards. This season the ARB honored the following individuals:

WILBUR E. BREWER PROFESSIONALISM AWARD:
Named in honor of one of the founders of WMI and longtime NDCMP advocate, this award was presented to WMI pilot Brook Herridge.

NORTH DAKOTA CLOUD MODIFICATION PROJECT

WILBUR E. BREWER PROFESSIONALISM AWARD

The North Dakota
Atmospheric Resource Board
with this Award certifies that

Brook Herridge

is hereby recognized for providing every effort to make the 2009 NDCMP a success. It is clear that Brook has the respect of his peers, as evidenced by several nominations for this award. His attitude, dedication and skills reflected his professionalism at a level deserving of the Wilbur E. Brewer Professionalism Award.

The Board and County Authorities wish to extend to Mr. Herridge their sincere appreciation for his efforts, which contributed greatly to the 2009 project.

Presented this 10th Day of September, 2009.

OUTSTANDING INTERN AWARD:

A desire to learn and further their education and experience attracts interns to the NDCMP. This award is given to the intern who had the greatest positive impact on the project and its daily operations. This was the second season this award has been presented; Erik Janzon received the honor.

North Dakota
Cloud Modification Project

Outstanding Intern Award

Personnel of the 2009 North Dakota Cloud Modification Project with this certificate hereby formally acknowledge that

Erik Janzon

is the acclaimed recipient of this award.
A desire to learn and further their education and experience attracts interns to the NDCMP. This award is given to the intern who had the greatest positive impact on the project and its daily operations. It is clear that Erik earned the respect of his peers, as evidenced by several nominations for this award. Erik's ambitiousness and hard work left a positive impact on the 2009 NDCMP.

Presented this 10th day of September, 2009.

Congratulations and thanks, Brook and Erik!

APPENDIX

A. TABLES OF AIRCRAFT ACTIVITY:

1) District I Cloud Base Aircraft
2) District I Cloud Top Aircraft
3) Seed 1 Generator Usage
4) District II Cloud Top Aircraft
5) District II Cloud Base Aircraft

B. AIRCRAFT SPECIFICACTIONS

TABLES OF AIRCRAFT ACTIVITY

(All flight times in hundredths of hours)

1. District I Cloud Base Aircraft

Note: The generator times for Seed 1 are not included in the DI daily summary totals due to the fact that they have a different seeding rate (C340 aircraft seed at a higher airspeed, which results in a higher flow rate). Seed 1's generator usage (in hours and grams) is included in the total line at the bottom. The specifics for Seed 1's generator usage can be seen in the following table on the next page. Note that Seed 2 on August 10, 2009 was switched from a Seneca to a C340 due to a maintenance issue. S2's generator time was then changed accordingly.

2009 DISTRICT I FLIGHT SUMMARY
CLOUD - BASE

					DAILY	RUNNING	MAIN-	GENERATORS		GENERATORS		B.I.P
DATE	HAIL	RAIN	RECON	OTHER	TOTAL	TOTAL	TENANCE	ONE	TWO	ONE	TWO	
	(---------all flight times in hundredths of hours----------)							(hours burned)		(grams burned)		(grams)
06/01/09					0.00	0.00	3.17					
06/05/09					0.00	0.00	0.66					
06/11/09			0.89		0.89	0.89						
06/15/09	3.22	2.22			5.44	6.33	0.31	0.31	0.56	62	225	525
06/16/09		1.34	0.20	1.39	2.93	9.26	0.32					
06/17/09		2.95	1.06		4.01	13.27		0.72	0.11	145	44	
06/18/09	3.27				3.27	16.54	0.58	0.51	1.27	103	511	225
06/19/09		1.34			1.34	17.88		0.16		32		
06/22/09	2.15				2.15	20.03			0.16		64	75
06/24/09	6.18				6.18	26.21			2.87		1,154	1650
06/26/09			0.72		0.72	26.93						
06/27/09	1.68		1.08		2.76	29.69			0.47		189	225
07/01/09	9.44			0.81	10.25	39.94			3.07		1,234	3525
07/02/09	2.19	2.11	0.91		5.21	45.15		0.43	1.23	86	494	
07/05/09	5.29				5.29	50.44		0.16	1.94	32	780	1200
07/06/09			0.51		0.51	50.95						
07/08/09	3.37				3.37	54.32		0.07	1.78	14	716	600
07/09/09	3.08				3.08	57.40						675
07/13/09	5.57				5.57	62.97		0.40	0.87	80	350	150
07/14/09			0.97		0.97	63.94						
07/19/09	4.99				4.99	68.93	0.47	0.16	1.48	32	595	375
07/26/09		0.73			0.73	69.66						
07/27/09					0.00	69.66	0.23					
07/29/09		1.67			1.67	71.33			1.13		454	
08/04/09			0.66		0.66	71.99						
08/05/09			1.28		1.28	73.27						
08/06/09			0.57		0.57	73.84	0.35					
08/08/09	9.51			2.47	11.98	85.82		0.10	3.63	20	1,459	1275
08/09/09	2.53	4.40			6.93	92.75		0.61	1.81	123	728	75
08/10/09				0.87	0.87	93.62						
08/12/09					0.00	93.62	0.47					
08/14/09			0.68		0.68	94.30	0.64					
08/19/09	5.32		0.55		5.87	100.17						1125
08/24/09			0.17		0.17	100.34	0.32					
08/29/09					0.00	100.34	1.26					
09/01/09	6.52				6.52	106.86	0.22		0.39		157	600
09/02/09				2.13	2.13	108.99	0.59					
09/05/09					0.00	108.99	0.27					
09/08/09	2.19			0.97	3.16	112.15						1050
TOTALS	**76.50**	**16.76**	**10.25**	**8.64**	**112.15**	**112.15**	**9.86**	**6.00**	**42.88**	**1,423**	**20,918**	**13,350**

TOTAL AgI RELEASED BY BASE AIRCRAFT: **35,691** **grams** MAINTENANCE (CONTRACTOR'S EXPENSE): 9.86 HOURS

TOTAL FLIGHT HOURS CONTRACTED:	**125.00**
FLIGHT HOURS FLOWN TO DATE:	**112.15**
FLIGHT HOURS REMAINING :	**12.85**

2. District I Cloud Top Aircraft

2009 DISTRICT I FLIGHT SUMMARY
CLOUD - TOP

					DAILY	RUNNING	MAIN-	GENERATORS		GENERATORS		DRY ICE	FLARES
DATE	HAIL	RAIN	RECON	OTHER	TOTAL	TOTAL	TENANCE	ONE	TWO	ONE	TWO	pounds	grams
								(hours burned)		(grams burned)			
06/15/09		1.75			1.75	1.75							180
06/17/09		1.24			1.24	2.99							60
06/18/09	3.36				3.36	6.35			0.18		105		240
06/24/09	2.53				2.53	8.88			0.36		211		1895
06/27/09	1.82				1.82	10.70							760
07/07/09			1.02		1.02	11.72							
07/29/09		3.88			3.88	15.60			0.37		216		440
08/05/09		2.79	1.14		3.93	19.53							1020
08/09/09	2.35				2.35	21.88							280
TOTALS	**10.06**	**9.66**	**2.16**	**0.00**	**21.88**	**21.88**	**0.00**	**0.00**	**0.91**	**0**	**532**	**0.00**	**4,875**

TOTAL AgI RELEASED BY C-340 AIRCRAFT: 5,407 grams
TOTAL DRY ICE USED ON PROJECT: 0.00 pounds

MAINT. CONTRACTOR'S EXP. 0.00 hours

TOTAL FLIGHT HOURS CONTRACTED:	25.00
FLIGHT HOURS FLOWN TO DATE:	21.88
FLIGHT HOURS REMAINING:	3.12

3. Seed 1 and Seed 2 (August – End of Project) (C340) Generator Usage

C340 GENERATOR RATES

DATE	GENERATORS		GENERATORS	
	ONE	TWO	ONE	TWO
	(hours burned)		(grams burned)	
6/15/2009		1.01		591
6/16/2009	0.25		73	
6/19/2009	0.42		123	
6/22/2009		0.64		374
6/24/2009		1.11		649
7/1/2009		1.57		918
7/2/2009	0.48	1.26	140	737
7/5/2009	0.08	1.95	23	1,141
7/9/2009		1.82		1,065
7/13/2009		1.25		731
7/19/2009	0.19	1.38	56	807
7/26/2009	0.10		29	
8/8/2009	0.04	1.89	12	1,106
8/9/2009	0.19	0.65	56	380
8/19/2009		2.62		1,533
9/1/2009	0.62	2.10	181	1,229
9/8/2009		0.86		503
TOTALS:	**2.37**	**20.11**	**693**	**11,764**

4. District II Cloud Top Aircraft

2009 DISTRICT II FLIGHT SUMMARY
CLOUD - TOP

					DAILY	RUNNING	MAIN-	GENERATORS		GENERATORS		DRY ICE	FLARES
DATE	HAIL	RAIN	RECON	OTHER	TOTAL	TOTAL	TENANCE	ONE	TWO	ONE	TWO	pounds	grams
								(hours burned)		(grams burned)			
06/01/09					0.00	0.00	1.77						
06/04/09		1.43			1.43	1.43		1.02	0.02	464	12	9.50	
06/05/09					0.00	1.43	1.29						
06/10/09		1.13			1.13	2.56						18.00	
06/11/09		3.14			3.14	5.70						115.16	
06/15/09		3.94			3.94	9.64						41.33	
06/16/09	6.90				6.90	16.54						139.49	1240
06/17/09	3.09		0.67		3.76	20.30	1.82					85.16	180
06/18/09	4.93	3.27			8.20	28.50		0.35		102		220.65	1460
06/19/09					0.00	28.50	2.65						
06/21/09	3.04	2.92			5.96	34.46		0.13	0.60	38	351	124.99	
06/22/09	2.80	3.79			6.59	41.05		0.63		184		145.49	
06/23/09			0.82		0.82	41.87							
06/24/09	4.85				4.85	46.72						156.83	2860
06/26/09	9.29			0.40	9.69	56.41		1.78	1.57	521	918	118.82	980
06/27/09				0.65	0.65	57.06							
06/30/09			2.55		2.55	59.61							
07/02/09		2.12			2.12	61.73						90.50	
07/04/09	2.31			0.51	2.82	64.55		0.50	1.17	146	684		
07/05/09		1.36			1.36	65.91						15.66	
07/07/09	2.46		1.08	0.93	4.47	70.38						64.33	
07/08/09	6.27				6.27	76.65						237.99	40
07/09/09	1.62			0.89	2.51	79.16						13.00	
07/12/09	5.24				5.24	84.40						145.49	480
07/14/09		1.51			1.51	85.91						21.16	
07/20/09					0.00	85.91	0.31						
07/29/09		5.18			5.18	91.09						247.50	160
08/04/09					0.00	91.09	1.83						
08/08/09			1.10		1.10	92.19	0.49						
08/12/09	1.97				1.97	94.16						42.66	
08/13/09			1.02		1.02	95.18							
08/14/09	2.25				2.25	97.43						19.00	
08/19/09	6.11		1.60		7.71	105.14			1.35		790	116.66	
08/24/09	4.34		0.48	2.08	6.90	112.04	1.44					88.50	
08/25/09					0.00	112.04	1.64						
09/08/09	2.50				2.50	114.54						82.50	
TOTALS	**69.97**	**29.79**	**9.32**	**5.46**	**114.54**	**114.54**	**13.24**	**4.41**	**4.71**	**1,455**	**2,755**	**2,360.37**	**7,400**

TOTAL AgI RELEASED BY C-340 AIRCRAFT: 11,611 grams
TOTAL DRY ICE USED ON PROJECT: 2,360.37 pounds

MAINT. CONTRACTOR'S EXP. 13.24 hours

TOTAL FLIGHT HOURS CONTRACTED:	240.00
FLIGHT HOURS FLOWN TO DATE:	114.54
FLIGHT HOURS REMAINING:	125.46

5. District II Cloud Base Aircraft

2009 DISTRICT II FLIGHT SUMMARY
CLOUD - BASE

					DAILY	RUNNING	MAIN-	GENERATORS		GENERATORS		B.I.P
DATE	HAIL	RAIN	RECON	OTHER	TOTAL	TOTAL	TENANCE	ONE	TWO	ONE	TWO	
	(---------all flight times in hundredths of hours---------)							(hours burned)		(grams burned)		(grams)
06/01/09					0.00	0.00	4.22					
06/02/09					0.00	0.00	1.19					
06/03/09					0.00	0.00	1.01					
06/05/09					0.00	0.00	1.45					
06/10/09		1.07	1.79		2.86	2.86		0.28		56		
06/11/09		6.71			6.71	9.57	0.19	3.35	0.01	673	4	
06/15/09	2.23	1.79	2.31		6.33	15.90		0.56		113		
06/16/09	5.05	9.00			14.05	29.95		4.34	2.14	872	860	
06/17/09	13.32		1.85		15.17	45.12		2.54	5.04	511	2026	150
06/18/09	14.82			0.80	15.62	60.74	0.17	5.30	5.03	1065	2022	3375
06/21/09	11.88	2.20	2.12		16.20	76.94	0.51	6.09	2.34	1224	941	750
06/22/09	3.56	2.77			6.33	83.27		1.23	2.02	247	812	375
06/24/09	9.18	1.53			10.71	93.98		2.70	2.40	543	965	2325
06/25/09				0.60	0.60	94.58						
06/26/09	14.80			0.59	15.39	109.97		4.34	3.79	872	1524	1125
06/29/09					0.00	109.97	3.01					
06/30/09	5.00				5.00	114.97	2.24	0.43	1.92	86	772	
07/01/09			0.88	0.62	1.50	116.47	0.60					
07/02/09		1.72	3.12		4.84	121.31	0.43	0.65		131		
07/04/09	5.22	1.64		0.61	7.47	128.78		0.22	2.84	44	1142	1350
07/05/09		4.48			4.48	133.26		0.92	0.33	185	133	
07/06/09					0.00	133.26	1.98					
07/07/09		1.70		0.73	2.43	135.69		0.97		195		
07/08/09	13.52	1.69	1.92		17.13	152.82		2.80	2.55	563	1025	975
07/09/09			1.23	3.97	5.20	158.02						
07/12/09	8.58			0.78	9.36	167.38		0.57	3.96	115	1592	3075
07/14/09		4.65			4.65	172.03		2.32		466		
07/15/09					0.00	172.03	1.39					
07/19/09					0.00	172.03	0.80					
07/22/09					0.00	172.03	0.70					
07/26/09					0.00	172.03	0.53					
07/29/09		8.77			8.77	180.80		5.36		1077		
08/02/09					0.00	180.80	0.35					
08/06/09		1.57			1.57	182.37	0.41	0.09		18		
08/08/09			1.24		1.24	183.61						
08/09/09		3.54	2.38		5.92	189.53		2.47		496		
08/10/09					0.00	189.53	0.25					
08/12/09	2.41				2.41	191.94			0.04		16	
08/14/09	9.96			3.85	13.81	205.75	0.49	0.91	3.01	183	1210	1875
08/19/09	6.13		3.11		9.24	214.99		1.34	0.45	269	181	1125
08/20/09					0.00	214.99	0.38					
08/23/09					0.00	214.99	0.26					
08/24/09	11.07		0.79	3.84	15.70	230.69	0.52	0.49	2.79	98	1122	3450
08/27/09					0.00	230.69	0.27					
09/01/09				0.49	0.49	231.18	1.10					
09/07/09					0.00	231.18	0.38					
TOTALS	**136.73**	**54.83**	**22.74**	**16.88**	**231.18**	**231.18**	**24.83**	**50.27**	**40.66**	**10,104**	**16,345**	**19,950**

TOTAL AgI RELEASED BY BASE AIRCRAFT: 46,400 grams MAINTENANCE (CONTRACTOR'S EXPENSE): 24.83

TOTAL FLIGHT HOURS CONTRACTED:	440.00
FLIGHT HOURS FLOWN TO DATE:	231.18
FLIGHT HOURS REMAINING :	208.82

AIRCRAFT SPECIFICATIONS:

CESSNA 340

4570 lbs maximum gross weight
3200 lbs typical empty weight
1370 lbs typical useful load
Turbocharged, 200 HP engines
Portable supplemental oxygen system
200 hp per engine at sea level
215 hp at 12,000 ft
225 mph max cruise speed
185 mph recommended cruise speed
70 mph stall in landing configuration
93 - 123 gallons usable fuel capacity
25,000 feet all engine service ceiling
14,400 feet single engine service ceiling
1200 feet per minute all engine rate of climb
190 feet per minute single engine rate of climb
1030 feet for take off over 50-foot obstruction
750 feet for take off ground roll
1720 feet land over 50-foot obstruction
950 landing ground roll
28 ft. 07 in. length
9 ft. 11 in. height
38 ft. 11 in. wingspan

PIPER SENECA II

6290 lbs maximum gross weight
4500 lbs typical empty weight
1790 lbs typical useful load
Pressurized cabin
Turbocharged, intercooled 310 HP engines
281mph max cruise speed
263mph recommended cruise
75mph stall in landing configuration
183 - 203 gallons usable fuel capacity
29,800 feet all engine service ceiling
15,800 feet single engine service ceiling
1650 feet per minute all engine rate of climb
315 feet per minute single engine rate of climb
2175 feet for take off over 50-foot obstruction
1615 feet for take off ground roll
1850 feet land over 50-foot obstruction
770 landing ground roll
34ft. 04 in. length
12 ft. 7 in. height
38 ft. 1 in. wingspan